Center Innovation Fund: JSC CIF

Proving Water Production out of Mars Analog Soil

Completed Technology Project (2016 - 2017)

Project Introduction

The combination of a regolith dryer, vapor-phase cleanup and passive condenser, and the dynamics of combining all three components into a system has never been demonstrated. Previous attempts to clean water by KSC to support ISRU were based on liquid phase cleanup and required consumables. The SBIR work by Paragon Space Development Corporation demonstrated the potential for a nafion membrane to be used as a vapor phase cleanup method, but was not tested with a realistic Mars simulant or passive condenser. The rate of vaporization, pressure drop across the nafion membrane and rate of condensation all determine the rate that water can realistically be extracted from regolith. A high fidelity Mars regolith simulant is required to evaluate the system. Regolith remediation techniques will also be investigated for removal of perchlorates/sulfates. This year's development of a small-scale breadboard could be followed up with a larger scale demonstration.

Anticipated Benefits

Sustaining human presence in space will require existing systems and vehicles to become more independent, incorporate intelligent autonomous operations, and take advantage of the local resources. Advances must be made in finding, extracting, and processing in-situ resources. This activity will address water extraction from Mars regolith. While the individual components to be used in this effort are well understood, the combination of the components into a working system has not been demonstrated. This activity will also test regolith remediation techniques for removal of perchlorates/sulfates.

Primary U.S. Work Locations and Key Partners

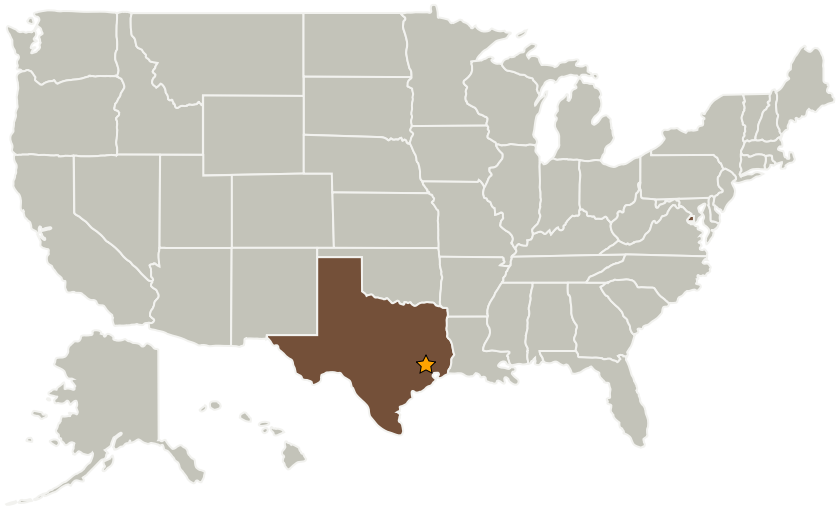

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Table of Contents

Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	1
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Technology Areas	3
Target Destination	3
Supported Mission Type	3

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Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas

Co-Funding Partners	Type	Location
Space Technology Mission Directorate(STMD)	NASA Mission Directorate	

Primary U.S. Work Locations	
District of Columbia	Texas

Project Transitions

October 2016: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Center Innovation Fund: JSC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

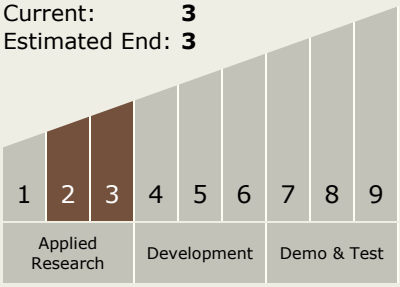
Carlos H Westhelle

Principal Investigator:

John E Gruener

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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July 2017: Closed out

Closeout Summary: The Mars regoilth simulant developed for this project is ba sed on the aeolian deposit known as 'Rocknest', which was analyzed by the Curi osiy rover in Gale Crater. Rocknest is representative of the windblown drifts that occur globally on Mars. Data from Curiosity confirmed the presence of several v olatiles that are released simultaneously with water as martian regolith is heate d. Mojave Mars Simulant (MMS), developed at the Jet Propulsion Laboratory (JP L), was used as the main component of the simulant (96 wt. %). Perchlorate (1 wt. %) and sulfate (3 wt. %) minerals were added in laboratory tests to mimic t he water release profile of Rocknest and to produce contaminating volatiles (hyr dochloric and sulfuric acids, respectively). Nafion is a commercially available ma terial with the unique capability of allowing water to pass through while filtering other compounds, including those found on the surface of Mars. Nafion is a Teflo n based material so its chemical robustness makes it a great candidate for long t erm water purification. We developed a test stand to demonstrate that nafion co uld be used to produce purified water extracted from Mars regolith. The test sta nd will also allow us to collect data on the rate of water extraction as a function of several variables such as membrane surface area and regolith temperature.T he individual components used in the test stand are well understood, however, t he combination of a regolith dryer, vapor-phase cleanup and passive condenser has never been demonstrated. The combination of these components drives the overall pressure and rate of water extraction. Restricting dust particles is import ant for this application. However, the use of an inline filter was too restrictive, a nd would not allow for a sufficient pressure differential across the nafion membr ane. Our test stand has been modified to allow for a much larger dust filter but t hat configuration has not yet been tested. Some pressure transducers may be s usceptible to a steam environment, even if they are rated for the temperature a nd pressure. This was the case with the first pressure transducers we used in ou r testbed. Due to complications with the test stand, we don’t have conclusive da ta at this time regarding water purity but this work will continue in FY18.

Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.1 In-Situ Resource Utilization
    - TX07.1.3 Resource Processing for Production of Mission Consumables

Target Destination

Mars

Supported Mission Type

Projected Mission (Pull)